Floristic Composition and Structural Analysis of Jibat Humid Afromontane Forest, West Shewa Zone, Oromia National Regional State, Ethiopia

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ABSTRACT

The study was conducted on Jibat Forest to determine the floristic composition, vegetation structure and plant community types. Systematic sampling method was used to collect vegetation data. A total of 74 quadrats each with a size of 20 m x 20 m for woody species and with in each major plot, five sub plots of size 1 m x 1 m were established for herbacious data collection. All plant species in each quadrat were recorded. Height and DBH of each woody plant species with height ≥ 2.5 m and DBH ≥ 2.5 cm were measured. A total of 183 species representing 161 genera and 73 families were recorded. Of the total species, 16 (8.74%) species are endemic to Ethiopia. Herbs had the highest composition followed by shrubs and trees. Six plant community types were identified from the cluster analysis and were named after 2 to 3 dominant species in each cluster. The description of each community type was given. The total basal area of the forest was 59.79 m^2/ha. Analysis of importance value index indicated that Ilex mitis had the highest value (27.7). The study revealed the prevalence of small-sized individuals in the Jibat Forest. Six population distribution patterns were recognized, i.e., inverted J, irregular, U-shape, bell-shape, Gauss-type and J- shaped patterns. Therefore, based on the results of this study, detailed study on regeneration potential of the forest is recommended.

Key Words: Floristic composition, Jibat forest, plant community; vegetation structure.

INTRODUCTION

Ethiopia has diverse macro- and micro-climatic conditions that have contributed to the formation of diverse ecosystems inhabited with a great diversity of life forms of both animals and plants.

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Altitudinal difference ranges from the highest peak at Ras Dashen, 4620 m above sea level down to the Afar Depression, which is 110 m below sea level (EFAP, 1994). As a result, the country is considered as one of the most important countries in tropical Africa with respect to endemism of plant and animal species (EFAP, 1994; Woldu et al., 2002; Senbeta, 2006).Historical sources indicate that about 35% of Ethiopia's land area was once covered with forest (EFAP, 1994). In the early 1950's, the forests that remained covered 19 million hectares or 16% of the land area and in the 1980's, coverage was reduced to 3.6%, by 1989 to 2.7 % (Bekele and Leykun, 2001; Gessesse, 2010). Clearance of natural vegetation to meet the demands of an ever increasing human population has been an ongoing process as a result of increasing demand for agricultural land that resulted in extensive forest clearing for agricultural use, the increasing livestock population resulted in overgrazing, and an increasing demand for fire wood and charcoal resulted that in exploitation of existing forests for fuel wood, and construction materials (Senbeta and Teketay, 2003; Soromessa et al., 2004). Ecological and environmental problems such as soil degradation, soil erosion and alteration of natural resources are just some of the negative effects resulting from the destruction of these habitats (Hundera *et al*., 2007). Furthermore, biodiversity resources along with their habitats are rapidly disappearing in the country (Teketay, 1992; Woldemariam and Teketay, 2001; Woldemariam, 2003; Senbeta and Denich, 2006). Loss of such forest resources would have great implication for the environment, biological diversity and socio-economic setup of the communities.

Forests worldwide are known to be critically important habitats in terms of the biological diversity they contain and in terms of the ecological functions they serve (SCBD, 2001). Ecologically, the forest gives important environmental benefits by providing carbon sink/ carbon storage service, watersheds protection services (protect soil erosion and flooding) and providing habitats for a large amount of animals (SCBD, 2001; Nune *et al*., 2010). Also, the forest serves as a source of food, household energy, construction and agricultural material, tourism and recreation values and medicines for both people and livestock (Bekele, 1994; Vivero *et al.*, 2005).

Botanical assessments such as floristic composition, species diversity and structural analysis studies are essential for providing information on species richness of the forests, useful for forest management purpose and help in understanding forest ecology and ecosystem functions (Giriraj *et al*., 2008; Pappoe *et al*., 2010). Knowledge of floristic composition and structure of forest is also useful in identifying ecologically and economically important plants and their diversities, protecting threatened and economical important plant species (Addo-Fordjour *et al*., 2009). The aim of this study was therefore, to document the floristic composition and make structural analysis of the Jibat Forest.

MATERIAL AND METHODS

Description of the Study Area

The study was conducted on Jibat Forest, located in Jibat district of West Shewa Zone of Oromia Regionalal National State. Geographically, it is located between $37^015'$ - $37^035'$E longitude and $8^035'$- $8^050'$N latitude. Its altitudinal range is between 2000-3000 meters above sea level.

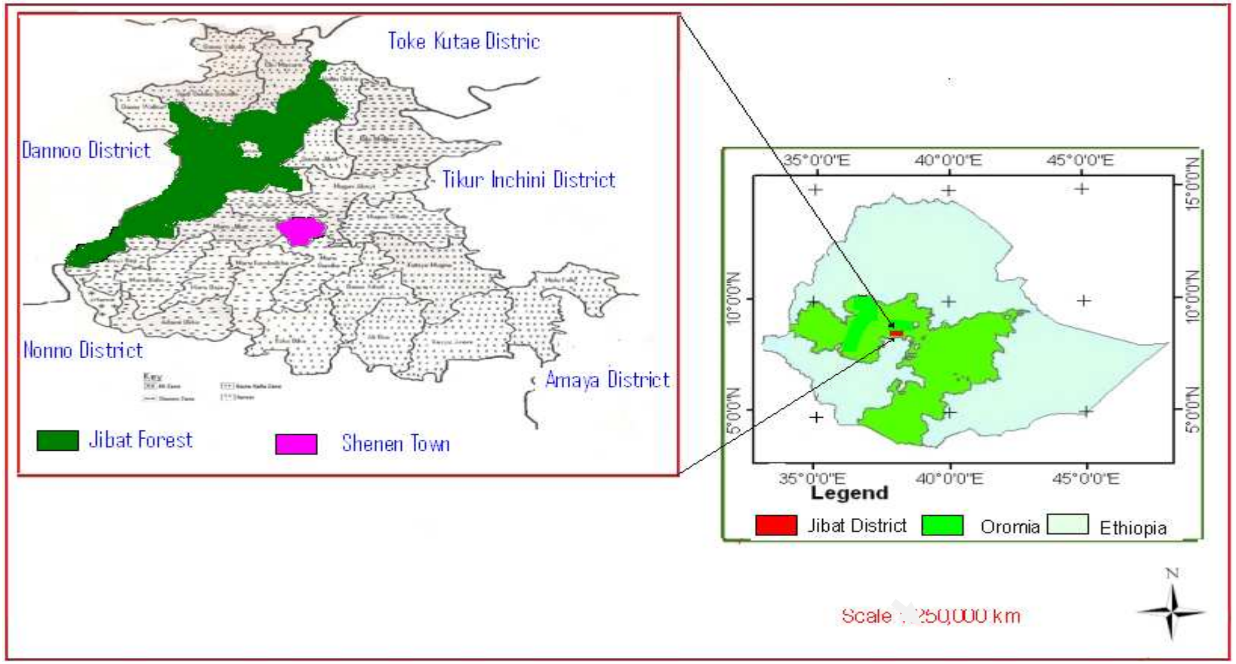

Figure 1 Map of the Jibat Natural forest, West Shoa, Oromia region

The area receives a mean annual rainfall of 1521.46 mm. The mean annual minimum and maximum temperatures of the area are 8°Cand 23.7°C respectively while the mean annual temperature is about 15.9°C and the average mean monthly minimum temperature is 4.92°C in December and the average mean monthly maximum is 26.1°C in March (ENMSA, 2011).

Sampling Design and Data Collection Methods

Sampling design

A systematic sampling technique was used to collect vegetation data in the Forest. Plots of size 20m x 20m (400m^2) were used for trees and shrubs, and subplots of 1m x1 m for herbaceous species at the four corners and one at the center of the large quadrat. Plots were laid systematically at every 200m along transect lines, which were 400m apart from each other.

Data collection

All plant species in each quadrat were recorded and their growth habit described. Additional plant species occurring outside quadrats but inside the forest were also recorded only as 'present', not used in the subsequent data analysis. The plant specimens were identified and deposited at the National Herbarium (ETH), Addis Ababa University. In each plot, height and diameters at breast height (DBH) of all woody plant species with height $\geq$ 2.5 m and DBH $\geq$ 2.5 cm were measured. Individuals having a height less than 2.5 m and DBH less than 2.5 cm were counted. The diameters at breast height (DBH) of all the woody plant at 1.3 meter above the ground were measured using a diameter tape. Height of trees was measured using calibrated bamboo stick. Altitude and geographical locations were measured for each quadrat using Garmin eTrex GPS.

Data Analysis

A hierarchical cluster analysis was used to classify the vegetation data in to plant community types. The analysis was based on the abundance of the species (the number of individuals). The decision on the number of plant communities was based on the multi-response permutation procedure (MRPP). The identified groups were also tested for the hypothesis of no difference between the groups using the multi-purpose permutation procedure (MRPP). Species indicator values were calculated using Indicator Species Analysis (ISA) (Dufrene and Legendre (1997) to determine indicator species. Indicator values are measures of the faithfulness of occurrence of a species in a particular group (McCune and Mefford 1999). In this study, a species is considered an indicator of a group when its indicator value is significantly higher at $p < 0.05$. Classification was performed using PC-ORD windows version 5 (McCune and Mefford, 1999).

For the description of vegetation structure, tree density, height, frequency, diameter at breast height (DBH), species importance value (SIV) and basal area were used. DBH classes (i.e. 1= 2.5-10, 2= 10-20, 3= 20 -50, 4=50 - 80, 5= 80 - 110, 6=110 - 140, 7=>140cm) (e.g. Lulekal *et al*., 2008). Basal area was calculated using the formula: $BA = \pi (d/2)^2$ where d is diameter at breast height. Density was a count of the numbers of individuals of a species within the quadrat. It was computed on hectare basis. The tree height was classified into nine classes (2.5 - 6 m, 6 - 9 m, 9 - 12 m, 12 - 15 m, 15 - 18 m, 18 - 21 m, 21 - 24 m, 24 - 27 m, 27-30 m, >30 m) (e.g. Hundera *et al.* 2007).

RESULT AND DISCUSSION

Floristic composition

A total of 183 plant species belonging to 159 genera and 73 families were identified from Jibat natural forest. Asteraceae and Fabaceae were found to be the dominant families in the forest represented by 14 (8.8%) genera and 18 (10%) species and 13 (8.2%) genera and 14 (7.8%) species respectively (Table 1). Fifty eight families were represented by less than three genera and three species and contributed about 82 (45%) of the total species.

Table 1. Five families with highest number of genera and species in Jibat Natural forest

Family	No. of Genera	%	No. of Species	%
Asteraceae	14	8.8	18	10
Fabaceae	13	8.2	14	7.8
Lamiaceae	7	4.4	10	5.6
Euphorbiaceae	7	4.4	9	5.0
Rubiacaea	7	4.4	7	3.9

Out of the total 183 plant species identified, 43 species (23.49%) were trees, 49 species (26.78%) were shrubs, 10 species (5.46%) were woody climbers, 8 species (4.37%) were climbers, 65 species (34.52%) were herbs, 2 species (1.09%) were ferns, and 3 species (1.64%) were epiphytes and 3 species (1.64%) grasses. Herbs had the highest composition followed by shrubs and trees (Fig. 2)

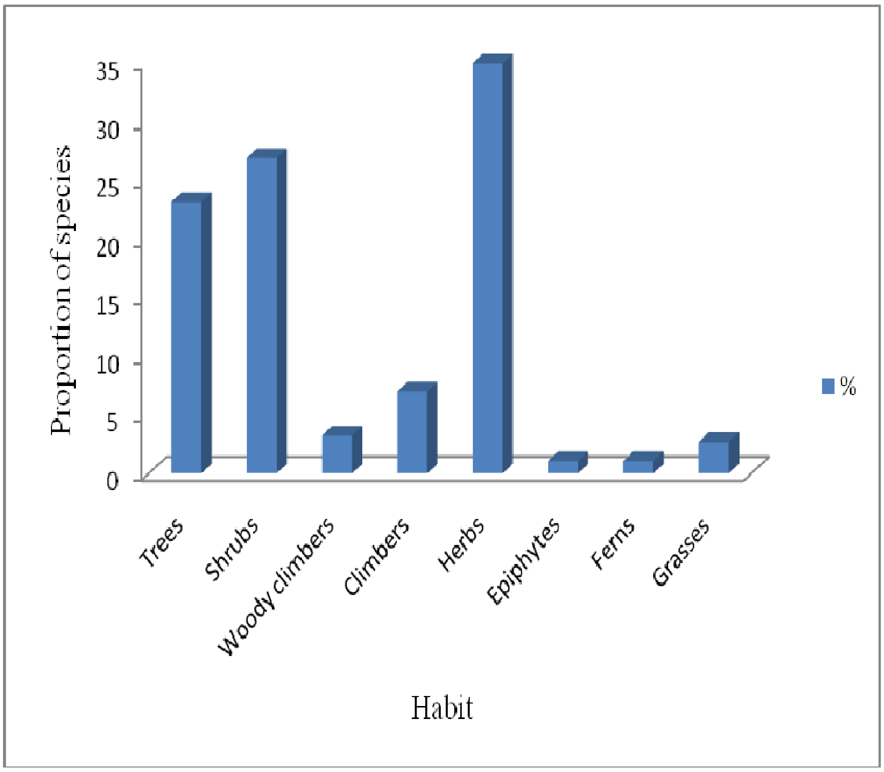

Figure 2. Distribution of plant species by their habits in Jibat forest

Of the total species, 16 (8.74%) species are endemic to Ethiopia. Out of this 13 species have been registered in the IUCN red data list of Ethiopia and Eritrea (Vivero *et al*., 2005) qualifying for vulnerable category (Table 2).

Table 2. Endemic species of Jibat Natural Forest and their IUCN categories (T = tree, S = shrub, H = herb, NT= Nearly Threatened, LC= Least).

Species	Family	Habit	IUCN category
Crotalaria roseni	Fabaceae	H	NT
Erythrina brucei	Fabaceae	T	LC
Impatiens tinctoria ssp. abyssinica	Balsaminaceae	H	LC
Kalanchoe petitiana	Crassulaceae	H	LC
Maytenus addat	Celastraceae	T	NT
Mikaniopsis clematoides	Asteraceae	C	LC
Millettia ferruginea	Fabaceae	T	LC
Solanecio gigas	Asteraceae	H	LC
Vepris dainellii	Rutaceae	T	LC
Solanun marginatum	Solanaceae	S	LC
Bothriocline schimperi	Asteraceae	S	LC
Impatiens tinctoria ssp. *abyssinica*	Balsaminaceae	H	LC
Chiliocephalum schimperi	Asteraceae	H	-
Cineraria abyssinica	Asteraceae	H	-
Plectranthus garckeanus Morton	Lamiaceae	H	-
Satureja paradoxa	Lamiaceae	S	-

Vegetation Classification

Six plant community types were identified from the cluster analysis. From the multiresponse permutation procedures (MRPP) the test statistic T value for the 6 communities was -28.8 at P < 0.001. The more negative T values indicate the strength of the separation among the groups. The agreement statistic A was 0.20 and high homogeneity with in groups (MRPP *A*=0.20). When the species composition and abundance within the groups are identical, A= 1 and 0 when the groups are heterogeneous. In this result, a plant species with a significant indicator value at *P* < 0.05 is considered as an indicator species of the group (Table 3).

The six plant communities identified were: *Maytenus addat - Brucea antidysenterica*, *Arundinaria alpina - Dombeya torrida*, *Mysine melanophloeos - Olinia rochetian*, *Ficus sur - Solanecio gigas*, *Apodytes dimidiata – Syzgium guineensee* and *Albizia schimperiana - Hypoestes forskaolii* and their descriptions are given as follows.

***Maytenus addat* - *Brucea antidysenterica* Community type**

This community type was found between 2543 and 2771 m a.s.l and represented by nine plots and 57 species. This community type was characterized by ten indicator species (Table 3). Associated species forming the tree layer include *Prunus africana*, *Ekebergia capensis*, *Apodytes dimidiata* and *Myrsine melanophloeos*. The shrub layer is dominated by *Vernonia auriculifera Rosa abyssinica* and *Rubus steudneri*. Woody climbers include *Embelia schimperi* and *Periploca linearifolia*. Herbs such as *Alchemilla abyssinica*, *Galium simense*, Cynoglossum *amplifolium*, *Girardinia bullosa*, *Carduus leptacanthus*, *Pentas schimperiana*, *Rumex napalensis*, *Achyrospermum schimperi* and *Cyperus distans* are some of the associated field layer of this community.

Table 3. Indicator Values (% of perfect Indication, based on combining Relative Abundance and Relative Frequency) of each species for each of the six groups and the Monte Carlo test (P*) of the significance observed for each species. (Bold values indicate indicator species at P*<0.05).

Species Name	**Communities**						
	1	**2**	**3**	**4**	**5**	**6**	**P***
Maytenus addat	**84**	0	7	0	0	0	0.0002
Brucea antidysenterica	**55**	0	10	1	8	0	0.0002
Bersama abyssinica	**50**	1	9	3	16	5	0.0002
Ilex mitis	**48**	1	27	7	0	0	0.0006
Discopodium penninervium	**33**	11	2	2	3	0	0.0126
Arundinaria alpine	0	**84**	1	0	0	0	0.0002
Dombeya torrida	0	**38**	0	0	0	0	0.0008
Conyza hypoleuca	0	**33**	1	0	0	0	0.002
Myrsine melanophloeos	7	32	**55**	0	0	0	0.0002
Olinia rochetiana	1	0	**49**	1	0	0	0.0012
Solanecio gigas	15	0	5	**51**	7	1	0.0002
Ficus sur	0	0	0	**44**	0	6	0.0024
Impatiens ethiopica	5	0	0	**42**	0	0	0.003
Impatiens tinctoria A Rich. Subsp. *abyssinica*	0	0	1	**36**	0	0	0.0048
Commelina Africana	0	0	0	**35**	1	0	0.0076
Cynodon dactylon	0	0	0	**33**	0	1	0.008
Syzygium guineense	0	0	0	0	**58**	24	0.0006
Apodytes dimidiata	1	0	1	0	**42**	0	0.0036
Albizia schimperiana	0	0	0	0	3	**55**	0.0004
Calpurnia aurea	0	0	0	0	0	**42**	0.0018
Polyscias fulva	0	0	0	0	3	**40**	0.0028
Olea welwitschii	0	0	0	2	16	**36**	0.0066
Hypoestes forskaolii	0	0	0	0	0	**33**	0.0016

Values in bold refer to dominant species of the community.

***Arundinaria alpina - Dombeya torrida* community type**

This community has 21 plots and 68 species and occurs within the altitudinal range of 2548 and 2926 m a.s.l. The community had 6 indicator species with significant indicator values (Table 3). The dominant species in this community type is *Arundinaria alpina,* the mountain bamboo. The tree layer that makes the community include *Schefflera abyssinica, Maesa lanceolata*, *Buddleja polystachya*, *Nuxia congesta*, *Erica arborea*, *Myrica salicifolia*, *Hagenia abyssinica* and *Olinia rochetiana*. Shrubs like *Vernonia auriculifera*, *Psychotria orophilia* and *Rubus steudneri* are the dominant of the community. The herb layer in this community includes *Pilea rivularis*, *Agrocharisn incognita and Trifolium tembense.*

***Myrsine melanophloeos - Olinia rochetiana* Community Type**

This community type occurs at altitudinal ranges from 2860 to 2979 m a.s.l, at relatively higher altitude. The community is comprised of eight plots and 36 species. This community was characterized by two indicator species (Table 3). Associated species forming the tree layer include *Erica arborea*, *Nuxia congesta*, *Hagenia abyssinica*, *Cupressus lusitanica*, *Dombeya torrida*, *Myrica salicifolia* and *Olea europea* subsp *cuspidata* and *Arundinaria alpina*. The shrub layer was dominated by *Crotalaria rosenii*, *Myrsine africana*, *Discopodium penninervium*, *Stachy aculeolata* and *Lippia adoensis. Stephania abyssinica* were the climber of this community. The herbaceouslayer includes *Medicago polymorpha*, *Oplismenus compositus*, *Satureja paradoxa* and *Achyrospermum schimperi*.

***Ficus sur - Solanecio gigas* Community Type**

This community type was distributed within the altitudinal range of 2298 to 2660 m a.s.l. The community consists of five plots and 29 species. It was characterized by eight indicator species (Table 3). The tree layer in this community contains *Ficus sur*, *Croton macrostachyus and Lepidotrichilia volkensii*. The shrub layer that makes the community includes *Solanecio gigas*, *Psychotria orophilia* and *Galiniera saxifraga. Urera hypselodendron* was the dominant climber in this community. The herbaceous layer is dominated by *Hydrocotyle mannii* and *Crassocephalum macropappum.*

***Apodytes dimidiata - Syzygium guineense* Community Type**

This community was located between 2307and 2506 m a.s.l. 18 plots and 55 species were associated in the community. The community had three indicator species with significant indicator values (Table 3). The tree layer in this community contains *Apodytes dimidiata*, *Syzygium guineense*, *Cassipourea malosana*, *Euphorbia ampliphylla*, *Vepris dainelli* and *Dovyalis abyssinica*. The most abundant field layer species is *Plectranthus garckeanus*, but also other herbs like *Amphicarpa africana* and *Arisaema schimperiana* at field layer form this community.

***Albizia schimperiana - Hypoestes forskaolii* Community Type**

This community was comprised of twelve plots and 57 species at altitudinal ranges of 2099 and 2534 m a.s.l. relatively; at lower altitudes. This community has 11 indicator species (Table 3). Additional characteristic tree species in this community type include

Celtis africana, *Millettia ferruginea*, *Pouteria adolfi-friederici*, *Ekebergia capensis*, *Pittosporum viridiflorum*, *Flacourtia indica* and *Chionanthus mildbraedii*. The Field layer consists of herbs like *Satureja paradoxa*, *Stellaria sennii*, *Polygonum nepalensis*, *Plantago lanceolata* and *Commelina africana*. This plant community has two endemic species (*Millettia ferruginea* and *Satureja paradoxa*). This community also contains four commercially important tree species such as *Pouteria adolfifriederici*, *Ekebergia capensis*, *Olea welwitschii* and *Celtis africana* (Bekele and Berhanu 2001).

Vegetation structure

For the description of the structure of Jibat Natural Forest, 54 woody species whose DBH > 2.5 cm and height > 2.5 m were selected. The total density of woody specie of Jibat Natural Forest was 720.3individuals/ha. *Arundinaria alpina* contributed 19.0% of the total density of DBH greater than 2.5 cm, followed by *Myrsine melanophloeos* (13.5%), *Ilex mitis* (7.5%), *Bersama abyssinica* (6.1%) and *Syzygium guineense* (4.6%). These five tree species contributed to 50.7% of the total density. On the other hand, the remaining 49 species together contributed 355.3 (49.3%) of total density (Table 4).

Table 4. Density and percent contribution of five tree species in Jibat Natural Forest

Species Name	Density	%
Arundinaria alpina	137	19
Myrsine melanophloeos	97	13.5
Ilex mitis	54	7.5
Bersama abyssinica	44	6.1
Syzygium guineense	33	4.6
Other 49 species	355.3	49.3
Total	**720.3**	**100**

DBH class distributions

The distribution of woody species in Jibat Natural Forest in different DBH classes is given in Figure 3. The number of stems in DBH class less than 10 cm is 392.9/ha (54.5%). As the DBH class size increases, the number of individuals gradually decreases toward the higher DBH classes. Similar result was reported by Lulekal *et al*. (2008) from Mana Angetu moist evergreen forest

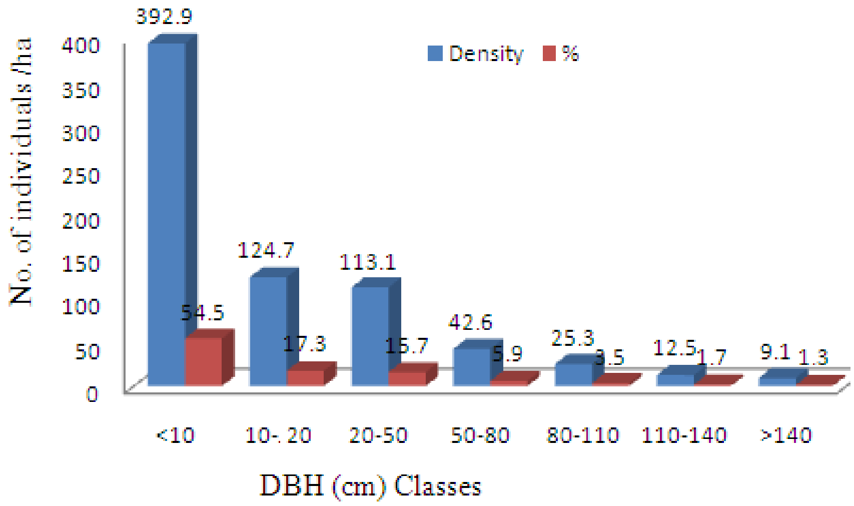

Figure 3. DBH class versus the number of individuals/ha

DBH class distribution of all individuals in different size classes showed a reversed J-shape distribution (Figure 3). This is a general pattern of regular population structure where the majority of the species had the highest number of individuals at lower DBH classes with gradual reduction toward high DBH classes. This suggests good reproduction and recruitment potential of woody species. Similar result was reported by Senbeta (2006) and Bekele (1993).

Height class distributions

Selected woody species in the study area could be conveniently classified into 10 height classes: 2.5- 6 m, 6.1-9 m, 9.1- 12 m, 12.1-15 m, 151-18 m, 18.1-21 m, 21.1-24 m, 24.1-27 m, 27.1- 30 m and > 30 m. The height class distribution of woody species in Jibat Forest (Figure 4) showed that more than 65% of the individuals had height less than 9 m (Height classes 1 and 2). Woody species in the height classes III and IV together are found to be 24.6%.

Height can be used as an indicator of age of the forest. The percent of woody species decreased with increasing height classes showing an inverted J-shape (Figure 4). The decrease in number of each height class towards the highest classes showed that the dominance of small-sized individuals in the Forest, which was the characteristic of high rate of regeneration. For example, about 55.7% of individuals are represented in the height class of 2.5 to 6 m, 19.1% in the height class 6.1 – 9 m and only <1% reaches a height of more than 30 m.

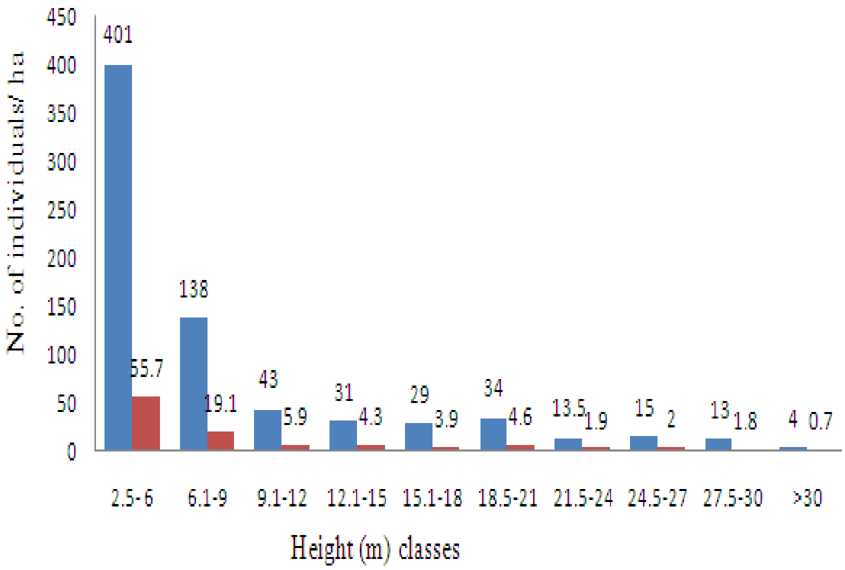

Figure 4. Height class distributions of woody species in Jibat Natural Forest

The patterns of height class distribution of the woody species reveals a high proportion of individuals in the lowest height class and few individuals in the largest height class.

Frequency

The seven most frequently observed tree species (Table 5) in the forest were *Arundinaria alpina* and *Bersama abyssinica (*95%) followed by *Ilex mitis* (69.5%), *Myrsine melanophloeos* (63.9%), *Brucea antidysenterica (*58.4%), *Syzygium guineense (* 47.4 %) *Croton macrostachyus* (41.9 %). The ten least occurred species were *Olea europea* sub sp. *Caspidata*, *Cupressus lusitanica*, *Poutera adolfi-friederici*, *Allophylus abyssinicus*, *Millettia ferruginea*, *Celtis africana*, *Pittosporum viridiflorum*, *Buddleja polystachya* and *Myrica salicifolia*, each constituting less than 0.5 relative frequency and a total of 3.79 relative frequencies.

Table 5. Frequency distribution of selected woody species in Jibat Natural Forest

Species	No. of Plots	Freq	% FR	RFR
Arundinaria alpina	52	70.3	95.0	8.2
Bersama abyssinica	52	70.3	95.0	8.2
Ilex mitis	38	51.4	69.5	6.0
Myrsine melanophloeos	35	47.3	63.9	5.5
Brucea antidysenterica	32	43.2	58.4	5.1
Syzygium guineense	26	35.1	47.4	4.1
Croton macrostachyus	23	31.0	41.9	3.6
Other 47 species	375	507.6	684.9	58.4
Total	**633**	**856.2**	**1156**	**99.1**

Freq = frequency, % FR = frequency percent and RFR = Relative frequency.

Basal area

The total basal area of Jibat Natural Forest was 60.9 m^2/ha. About 44.6 (73.1%) of the total basal area was contributed by ten tree species: *Syzygium guineense* (15.3%), *Olea welwitschii* (14.3%), *Ilex mitis* (12.3%), *Ekebergia capensis* (6.7%), *Ficus sur* (4.8%), *Croton macrostachyus* (4.4%), *Prunus africana* (4.4%), *Podocarpus falcatus* (3.9%), *Myrsine melanophloeos* (3.6%) and *Olinia rochetiana* (3.4%). On the other hand, the remaining 44 species together contributed 16.3 (26.9%) of total basal area but their contribution to density was about 460.3 (63.8%) of the total density (Table 6). The species with the largest contribution in basal area can be considered the most important woody species in the forest.

Table 6. Basal area, density and their percent contribution of ten tree species in Jibat Natural Forest

Species Name	Basal area	%	Density	%
Syzygium guineense	9.3	15.3	33	4.6
Olea welwitschii	8.7	14.3	10	1.5
Ilex mitis	7.5	12.3	54	7.5
Ekebergia capensis	4.1	6.7	6.4	0.9
Ficus sur	2.9	4.8	5.7	0.8
Croton macrostachyus	2.7	4.4	25	3.5
Prunus africana	2.7	4.4	7.8	1.1
Podocarpus falcatus	2.4	3.9	4.1	0.6
Myrsine melanophloeos	2.2	3.6	97	13.5
Olinia rochetiana	2.1	3.4	17	2.4
Other 44 species	16.3	26.9	460.3	63.8
Total	**60.9**	**100**	**720.3**	**100.0**

Comparison of the contribution of the different DBH to the total area shows that more than 47.6 (80.2%) of the total basal area was contributed by those their DBH were greater than 50 cm. There is a considerable decrease in number of individuals with increasing DBH size and basal area. The contribution of the first DBH class (2.5 - 10 cm) to the density was about 54.5% but their contribution to basal was about 3.4%. On the other hand individuals in the DBH classes greater than 50cm had a density of about 89.5 (12.4%) (Figure 6) but they are large sized individuals. Similar result was reported by Hundera and Gadisa (2008) and Lulekal *et al*. (2008). In general basal area increases with increasing in DBH classes from first to third DBH classes then slightly decrease at fourth DBH class than gradually increase with increasing DBH classes (Fig. 5). The fourth diameter class (50-80 cm) has relatively low contribution to the basal area due to less number of individuals which resulted from selective cutting of some species. Basal area gradually increases with increasing DBH classes from first to fourth DBH classes then equals at fifth and sixth classes and then increase in DBH class seven (Figure 5).

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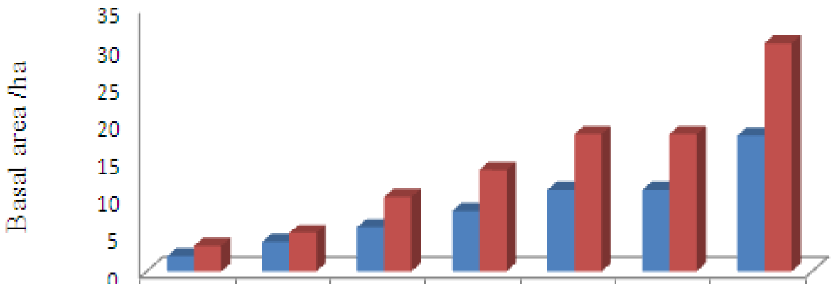


	2.5-10	10.1-20	20.1-50	50.1-80	80.1-110	110.1-140	>140
Basal Area	2	3.9	5.9	8	10.8	10.8	18
%	3.4	5.1	9.9	13.5	18.2	18.2	30.3

Figure 5. Distribution of basal area by diameter class

The basal area of Jibat Natural Forest (60.9 m^2/ha) is greater than the value of Masha Anderacha (49.80 m2/ha) (Yeshitela and Bekele, 2003), Dindin (49 m2/ha) (Shibru and Balcha, 2004), Alata-Bolale (53.33 m2/ha) (Enkosa, 2008). But it is less than Mana Angetu (94m^2/ha) (Lulekal *et al.*, 2008) and Belete Natural forest (90.6m^2/ha) (Hundera and Gadisa, 2008).

Population structure of Jibat Natural Forest

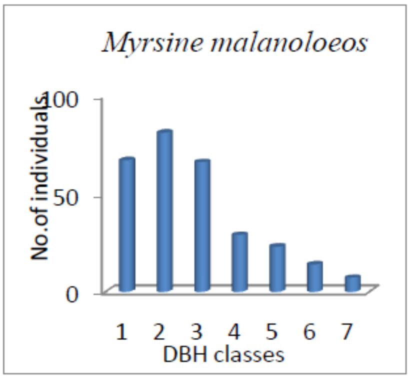
Diameter class distribution of selected tree species demonstrated various patterns of population structure, implying different population dynamics among species (Figure 6a-e). The first pattern was an inverted J-shaped distribution exhibited by species with high number of individuals in the first and second DBH classes and with gradual decreases towards higher DBH classes (Figure 6a), which suggested good reproduction and healthy regeneration potential of the species in the forest (Bekele, 1993; Senbeta, 2006). This group is represented by *Chionanthus mildbraedii*, *Maytenus addat*, *and Myrsine melanophloeos.* Small trees like *Brucea antidysenterica*, *Teclea nobilis*, *Bersama abyssinica*, *Erica arborea* and *Galiniera saxifraga* do not have upper DBH classes.

The second pattern was formed by species having irregular distribution over diameter classes. Some DBH classes had small number of individuals while other DBH classes had large number of individuals (Figure 6b). This irregular pattern distribution was due to selective cutting by the local people for construction and firewood. Overgrazing which affects the seedlings under the mother tree could be another reason for such irregularities. Examples of this pattern are *Syzygium guineense* and *Olea welwitschii.*

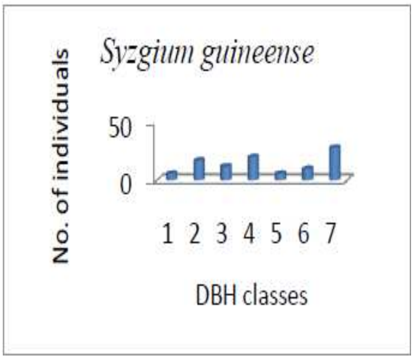
The third pattern was a U-shaped curve (Figure 6c), formed by species with little or no individuals in the middle DBH classes and represented only by the lower and higher DBH classes. The intermediate diameter classes are poorly represented may be due to selective removal of medium sized individuals (Hundera et al., 2007).

The fourth type (Figure 6d), shows a Gauss-type distribution pattern, with the first and second DBH classes having a low number of individuals, a gradual increase in the number of individuals towards the medium classes, and subsequent a decrease in number towards the higher DBH classes. This pattern indicates a poor reproduction (Bekele, 1993; Senbeta, 2006) and recruitment of species, which may be associated with the overharvesting of seed bearing individual (Senbeta, 2006). For instance *Polyscias fulva* and Nuxia congesta have such type of pattern.

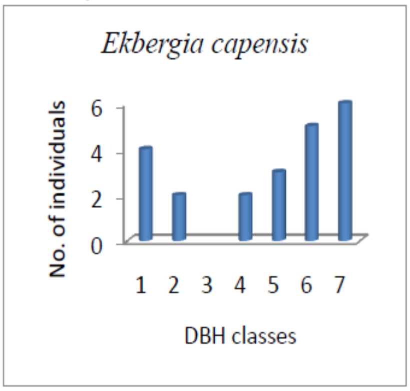
The fifth type (Figure 6e) shows a J-shaped distribution pattern where the number of individuals is low in the first and second DBH classes but increases toward the higher classes. Such pattern shows poor reproduction patterns (Bekele, 1993; Senbeta, 2006) and hampered regeneration due to the fact that either most trees are not producing seeds due to age or there are losses due to predators after reproduction (Senbeta 2006). This regeneration pattern was observed in *Ilex mitis and Apodytes dimidiata*.



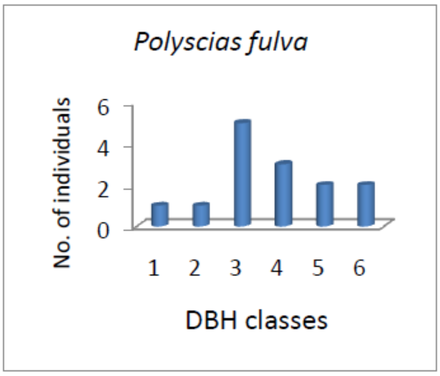
a)



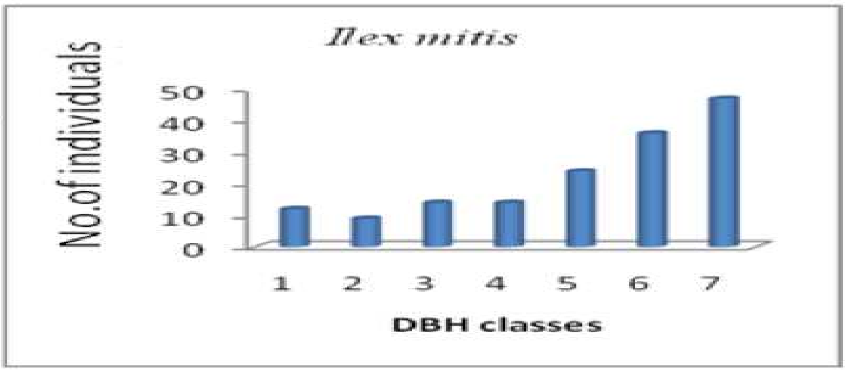
b)



c)



d)



e)

Figure 6a-e Population structure of some tree species (1= 2.5-10 cm, 2 = 10.1-20, 3 = 20.1 -50, 4 = 50.1-80, 5 = 80.1-110, 6 = 110.1-140 and 7= >140 cm)

CONCLUSIONS

The Jibat humid Afromontane forest is one of the National Forest Priority Areas in Ethiopia and is a home for diverse groups of plant species. It consists of 183 species of vascular plants belonging to 159 genera and 73 families. Asteraceae was found to be the most dominant family followed by Fabaceae, Lamiaceae, Euphorbiaceae and Rubiaceae. Of the total species, 16 species are endemic to Ethiopia.

Six plant communities were identified and described with varying degree of species richness, evenness and diversity. Analysis of population structure of the most common species showed that most of species exhibit normal population structure. On the other hand, tree species such as *Pouteria adolfi-friederici*, which are economically and ecologically important, had population structures that exhibited abnormal recruitment with poor regeneration due to selective removal of some individuals. The density of woody species decreases with increasing DBH and height indicating predominance of small-sized individuals in the forest. This implies that the Forest is in a good state of reproduction.

Based on the results of the study, the following recommendations were suggested:

- Participatory forest management programs should be introduced and implemented to create awareness and sense of ownership of the local people so that local communities take responsibility for the management and conservation of the forest and become beneficiaries of the economic payback derived from this activity;
- Further research on regeneration status and soil characteristics of the forest.
- Detailed ethnobotanical studies are also required to explore the wealth of indigenous knowledge on the diverse uses of plants and their implication in conservation

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